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PLANT PROTECTION LEGISLATION.

FURTHER STUDIES IN TROPICAL LAND TENURE.

COMPARISON OF FOUR SUGAR-CANE VARIETIES IN TRINIDAD.

DETERIORATION OF HARVESTED SUGAR-CANE.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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PLANT PROTECTION LEGISLATION.

WITHIN the last thirty years, the spread of insect pests and diseases of crop plants has been arrested to a very considerable extent by the adoption in almost all countries of legislation controlling the import of plants and crop products. It is only very recently, however, that much progress has been made in unifying and co-ordinating the measures applied in different parts of the world; any attempt at international planning and co-operation on an adequate scale, for a problem so obviously international, is still largely a matter for the future.

There is therefore much encouragement to be found in a recent important paper "A Summary of Legislation relating to the Introduction of Plants into the Colonial Dependencies of the British Empire as at the end of December 1936" issued by the Colonial Office (Colonial No. 141, H. M. Stationery Office, 1937), largely as a result of recommendations made at the Third Imperial Mycological Conference held in London in 1934. This summary shows that all British Colonial Dependencies, with a few unimportant exceptions, have adopted a carefully-planned system of legislation against the introduction of crop pests and diseases. In most cases there is an absolute prohibition of importation (except by the local Department of Agriculture, under careful control) of any living part of the crop plants most extensively cultivated in each particular area, and the import of other living plants is subject to inspection by plant protection officers, who have power to hold and to destroy material that appears likely to serve as the means of entry for any disease or pest. These legislative measures may be regarded as reasonably satisfactory under present conditions, though they are of course undergoing constant improvement, and in their application there is obviously room for increased energy and efficiency. This summary of regulations in force should be of great value to those concerned in the planning and organising of plant quarantine and inspection services.

Of particular interest are some of the recent developments towards unification, mentioned in the Introduction to the Summary. These include Plant Exchange Conventions established between the various Colonies in West Africa and between the Union of South Africa, Southern Rhodesia, the Belgian Congo, Northern Rhodesia and Nyasaland; the efforts towards similar co-operation between the East African Dependencies

of Kenya, Uganda, Tanganyika and Zanzibar; the co-ordination of legislation in the West Indian group of colonies now being considered by the recently established Central Plant Quarantine Committee in Trinidad; the acceptance by all Colonial Governments of a uniform health certificate for exported planting material; the establishment of plant quarantine stations at Amani for the East African group of Dependencies, at Trinidad for the West Indian area, as well as in Mauritius.

These developments, however important, draw attention to the urgent need for co-operation on an international basis. A country surrounded by a wide ocean barrier can reduce the influx of foreign organisms almost, though never completely, to the point of safety, but the spread of many pests and diseases across a long land frontier cannot be adequately arrested by human control. The planning of international trade, with regard to the dissemination of diseases and pests, is scarcely to be expected in the near future, but there are many aspects of the problem which should be the concern of an international organisation.

Another aspect of the problem of plant protection services which stands in need of greater attention is that of public enlightenment. Irresponsible criticism and irritation at restrictive measures is of course largely due to ignorance and can be dispelled simply by drawing attention to the disastrous spread of pests and diseases in the past and the very considerable efficacy of plant protection measures now being enforced. The criticism that restrictions on import are sometimes made under the guise of plant protection, when their real function is that of a protective tariff, should be met by scrupulous care in separating the problems. More difficult to answer sometimes is the criticism that certain forms of legislation serve to plug small holes in the defensive barrier, while wide breaches are left open. Such criticism should be welcomed as an incentive towards improvement. Critics should perhaps be reminded of the difficulty and complexity of the problem of legislating against the spread of diseases and pests, and of the fact that those entrusted with the framing and execution of legislation are as desirous of avoiding harmful restrictions as they are of preventing the spread of enemies of mankind.

These few lines on a great and complicated problem may be closed with a brief consideration of the present position and of prospects for the future. It is scarcely necessary to point out that in the past the lack of restrictions on the movement of planting material has resulted in countless introductions of a disastrous nature, a large proportion of which could have been prevented by methods now well established. In the United States of America, for example, it seems safe to say that more than half of the tremendous damage by insects to agriculture is caused by introduced pests. In the Hawaiian Islands, where scores of noxious insects have been established, there was probably no major insect pest present when the islands were first visited by white voyagers. The measures adopted by the more efficient governments within the last fifty years have certainly reduced the spread of pests and diseases to a small fraction of its former magnitude, quite apart from the fact that those organisms which are most difficult to hold back have long since attained their maximum range and so no longer concern us here. The method of quarantine for introduced planting material, in isolation under strict scientific control, has long ago proved its efficacy. Probably scarcely any pests and diseases have increased their range by means of plants introduced through a well-established quarantine station.

The need for maintaining and increasing activity against the spread of enemies of crops may be demonstrated by mentioning the following introductions of major insect pests during the last ten years: of the Colorado Potato Beetle from North America to European countries; the Cotton Boll Weevil from North America or Cuba to Haiti; the Coffee Berry-borer to Ceylon; the Mediterranean Fruit-fly to Switzerland and for a short time before its extermination, to Florida. An interesting very recent case is the discovery in Hawaii in April and May 1938 of several flourishing colonies of a Giant African Snail, *Achatina fulica* (Fér.), notorious as an introduced pest in the Orient, which was imported into Hawaii in ignorance of legislation, but fortunately exterminated before it became established. Records published annually by the Hawaiian Entomological Society show that an average of about twenty species of insects of all kinds, harmful or otherwise, become established in the Hawaiian Islands each year. Perhaps the strongest argument for plant quarantine and similar measures is to be found in the long lists, published by the U. S. Department of Agriculture, of countless potential foreign pests intercepted annually at American ports.

The fact that many pests have so recently overcome existing measures against their spread is an argument for increased vigilance, but at the same time it raises the important question: can restrictive measures limit the distribution of many diseases and pests indefinitely, or will most of them gradually spread until they have reached the limits set by climate, food supply and other natural factors? An answer would have to take into consideration such contingencies as world wars and their disruption of routine services, the increase in transport by air, and so on. For the meantime it should be remembered that even the slowing-down of the spread of harmful animals and plants will more than justify the labour and cost of the proper precautions. Finally, advances in methods of control will render the establishment of many foreign organisms less harmful than at present, and there is hope also in increased possibilities for extermination of pests after their introduction. These possibilities have already been demonstrated in the case of the Colorado Potato Beetle in England, and especially in the extermination of the Mediterranean Fruit-fly after its establishment in many parts of Florida in 1929-30.

A. M. A.

FURTHER STUDIES IN TROPICAL LAND TENURE.

By H. M. Leake.

(*Continued from Tropical Agriculture*, Vol. XV, No. 8, p. 175.)

III.—EAST AFRICA.

Kenya.

As was explained in an earlier series of articles, the land problem was, at that time, in a state of great uncertainty. A dual policy had been inaugurated. While reserves had been demarcated for the different tribes within which the local customary system of tenure was to hold force, a considerable tract in the Highlands had been reserved for European settlement and in this the permanent settlement of natives was disallowed. It was a demarcation which had never been accepted by some of the tribes in question and there was the further objection that the reserves, as demarcated, had not discounted the potential needs of the growing tribal population. It is unnecessary here to enter into the legal aspects of this question; these lay in the legal interpretation of the various agreements entered into with the various tribes during the process of occupation and of the Ordinances laying down the relations of the Crown to the land. That has an historical, as well as a legal aspect.

The main question arose in the case of the Masai, that formerly powerful and warlike tribe which Sir Charles Eliot, even as late as 1901 after it had been reduced to a shadow of its former self by intra-tribal disputes and disease, described as the most important and dangerous of the tribes. As a pastoral tribe, the Masai ranged over a wide stretch of country and its decadence coincided with the early European settlements. It is hardly surprising that the vast expanses left almost uninhabited should be thrown open to European settlement and, in fact, alienation to Europeans proceeded rapidly. But this position was not recognized by the Masai until the first Masai agreement of 1904 demarcated a dual reserve, an agreement which was superseded by the later agreement of 1911 unifying the two reserves into one to the South of the railway. Thus started the system of tribal reserves of which over 50 are now demarcated.

The influx of European settlers early in the century preceded any clear knowledge of tribal claims to land and alienations proceeded throughout that tract, defined with any degree of precision only in the East and West, which came to be known as the European Highlands. Land alienation to Europeans and demarcation of reserves proceeded side by side and, in some cases, in contradiction. Thus, though the Nandi Reserve was demarcated by treaty with the chiefs in agreements dated 1907 and 1910, alienation took place in 1912 and again in 1919, when land was taken by Government under a Soldiers' Settlement Scheme. Though all rents are credited to the Local Native Council, the original contradiction remained.

But the major problem concerned the Kikuyu. As here presented, the problem differed materially from that of the Masai. The latter are a pastoral people estimated at approximately 50,000 souls occupying a tract of some 1,500 square miles, a density of between 3 and 4 per square mile; the Kikuyu are an agricultural people numbering approximately half a million and occupying a tract of some 1,700 square miles, a density of 283 per square mile. Here are raised two fundamental questions with regard to the Reserves; how are they to be adjusted to the future demands either of an expanding, or of a diminishing population and has any tribe, as the result of any agreement, a specific and perpetual monopoly in the reserved land when it is, for such reason as diminishing population, unable effectively to use the whole area? Before the British occupation such maladjustments would have been rectified by the forces of inter-tribal pressures and the logical answer is that flexibility in the adjustment of reserve boundaries is essential but that the method of adjustment requires to be peaceful instead of forceful. In the case of the Masai Reserve, not only are there large tracts of good agricultural land which could be put to more profitable use than grazing, but parts are fly infested, useless for grazing but capable of being freed from fly by clearance for agriculture. Already an infiltration of Kikuyu into the Masai Reserve has taken, and continues to take place, but security of tenure is slight. The questions thus raised, therefore, concern not merely the demarcation of an area for European settlement but of inter-tribal settlement.

An added problem involves the disposition of labour returning from serving contracts whether as labour tenants on European farms or as town workers. Such labour is, in a sense, detribalized and, especially in the case of the densely populated Kikuyu Reserve, finds difficulty in re-establishing itself within the tribal organization. Under the Resident Native Ordinance (33 of 1918) these Resident Native Labourers receive by contract sufficient land to build a house and to cultivate for their own needs, are allowed to keep a defined number of cattle with right to pasture and, in return, are under obligation to work for a minimum of 180 days per annum at a specified wage. But they have no certainty of tenure, and, on termination of the contract, have to find a home elsewhere,

Not only do they return with additional stock but changes have frequently taken place in their home country which have absorbed the land formerly occupied by them.

Lastly, there is the problem of the limitation of the right to land in the Highlands to Europeans. Europeans are not the only peoples who have found Kenya a desirable country in which to reside. Indians have flocked to the country and have played a large part in opening it up, particularly in the construction of the railway. Following the labourer has come the Indian trader. Among this group have arisen capitalists, desirous and capable of investing their greater or less capital in land. These have felt it a hardship that the original limitation of the initial grant of land in the Highlands has been stretched to preclude transfer from Europeans to Indians.

The Native Lands Trust Ordinance (9 of 1930), which repealed part 6 of the Crown Lands Ordinance (12 of 1915) as amended in 1926 (Ord. 22 of 1926) and 1929 (Ord. 5 of 1929), was designed to meet the requirements of the Reserves by the establishment of a Native Lands Trust Board with Local Boards for each Administrative District. This Ordinance was designed to implement the findings of the East African Commission of 1925 which recognized the necessity of defining the position of the Crown relative to Native Lands, and the primary function of the Board was to act as Trustee in the interest of the natives. But there are two aspects of this Trusteeship; one external, the security of the tribe as a whole in possession of its land, the other internal, the security of the groups, families and individuals each in its particular holding. This latter the Ordinance failed to cover fully and there remains here an outstanding question.

In 1933 these doubts and uncertainties relative to land were referred to a Commission the Report of which appeared in 1934*. This comprehensive document of nearly 600 pages is a mine of information on the subject of tenure in the Colony, but, as the terms of reference show, its primary objective was to devise a scheme to allay the doubts and remove the grievances which had arisen through the earlier handling of the problem. These terms of reference included a consideration of:—

(1) the needs of the native population present and prospective;
(2) the desirability of setting aside further areas of land for present or future use
  (*a*) of native tribes,
  (*b*) detribalized natives;
(3) the claims of natives to lands alienated to non-natives or not yet so alienated;
(4) a definition of the area known as the Highlands, and
(5) a review of the working of the Native Lands Trust Ordinance.

* Report, Kenya Land Commn., 1934; Cmd. 4556.

It is unnecessary here to consider the Report further than to say that it recommends recognition of the following grouping of lands:—

(1) European Highlands, defined in the same manner as tribal reserves;
(2) Native Lands (Class A lands), the present native reserves with boundaries amended;
(3) Native Reserves (Class B1 lands) additions to Native Lands made on economic grounds;
(4) Temporary Native Reserves (Class B2 lands) additions made for reasons which are probably temporary only, and
(5) Native Leaseholds Areas (Class C lands) where a private form of tenure suitable for detribalized natives would be available.

These terms of reference and the Report deal, it will be noted, only with that human aspect of the question, the adequacy of available land and security of possession. That further aspect of all tenure problems, the suitability of a system to provide that excess of produce by the disposal of which the growing needs for an advancing standard of living can be met, neither enters into the terms of reference nor is dealt with in the Report. One suggestion only has a bearing on this aspect. With regard to Class C lands the Report notes (Sec. 1933) that the difficulties of settling large numbers of natives in unfamiliar surroundings will be less acute if facilities are granted for a few large enterprises conducted by Europeans, especially those which admit of a high degree of co-operation with natives, and an economic survey of such lands is recommended. That any true appreciation of this aspect is absent from the Commissioners' thoughts here, however, is evident from their further statement that such enterprises will help the natives by developing the resources of the country, *by offering employment and by creating a local market for produce.*

Such is the position in broad outline and the two systems may now be briefly reviewed. As applied in the case of settlers in areas not reserved for tribes, the unit is commonly the plantation or, as pasture forms a prominent feature, the estate. Normally these estates are of a size falling within the means of the individual but they may, as in the case of sisal, be held corporately. The tenure, except in the case of a few outright alienations in the early days, is on a 999 years lease with rental revisable every 30 years, thus showing the Indian influence. The lease is transferable subject to the Governor's veto which is exercised, in the case of the Highlands, against transfers to others than Europeans. The details of the lease are governed by the Crown Lands Ordinance (12 of 1915). These estates are worked on a basis of paid labour, the terms of engagement of which are defined by the Resident Native Labourers (Squatters) Ordinance (33 of 1918) already mentioned. The large proportion of estates in individual ownership raises two problems; one, which is common

to all groups of independent producers of a product for export, that of grades, though, with the relatively large size of the unit and the higher standard of education of the European community, the problem here is less difficult of solution than in the case of a native peasantry. The second is financial; the vulnerability in times of depression of relatively small units of capital privately held. The first of these points will be dealt with below. With regard to the latter, here, as in any plantation system, the economy which is most readily adopted in times of depression, lies in a reduction of the labour bill. While it is the first step to be adopted, it is a step which, if carried too far or over too long a period, leads to depreciation of the estate and to lower yields. The recent depression, however, produced a strain which this method alone was unable to bear and, in 1930 a Central Agricultural Advances Board was established under the Agricultural Advances Ordinance (12 of 1930). The Board, having an official majority, was empowered to make advances to farmers, defined as any owners or occupiers of land used for agricultural purposes, from funds placed at its disposal by the Legislative Council. These advances were a charge on the land and the disposal of the crops fell to the Board. A further step was taken by the Land and Agricultural Bank Ordinance (3 of 1931) which established a Bank with capital derived from loans voted by the Legislative Council, overdrafts from other Banks and Land Bank bills. The Bank was empowered to make advances to natives with the approval of the Local Native Council. Later, the Agricultural Mortgages Relief Bill (35 of 1934), a temporary measure prolonged by an amending Ordinance (28 of 1937) to the end of 1937 with authorization of further extensions by proclamation, defined a legal process to prevent foreclosures. Again, the Farmers' Assistance Ordinance (18 of 1936) empowered individuals or companies engaged in farming, planting or pastoral work to apply to local committees for a staying order, established a Farmers' Conciliation Board with a Judge as Chairman and the Land and Agricultural Bank as Agent.

Within the Reserves no legislation has been passed dealing with tenure other than that described in the earlier series, presumably pending discussion of the findings of the Land Commission's Report. The complexities of the various systems under which land is held in the different Reserves has been sufficiently discussed there. The point of major interest is the drift towards individual tenure, as opposed to communal tenure, with the growing density of population; a clear indication that the native systems are dynamic. Throughout the Reserves the primary objective of native production is the provision of personal needs and the local market. Production for export is a secondary consideration. The absence of a cash basis for the right to occupy land leaves the Reserves comparatively free from adverse reactions to depression.

When the development of an export trade in agricultural produce is considered, it is found that reliance has been placed on the same guiding principles as have been followed elsewhere; official regulation and control have been increasingly relied on with the Agricultural Department the effective agent. The Diseases of Animals Ordinance (1 of 1906) and the Diseases of Plants Prevention Ordinance (10 of 1910) are early instances; 1912 saw the Wattle Bark Ordinance (14 of 1912) passed, while the Coconut Preservation Ordinance (21 of 1915) established an inspectorate under the Department of Agriculture to enforce regulations for the destruction of dead and diseased trees and for the disposal of refuse likely to harbour pests. The Coffee Planters and Dealers Ordinance (10 of 1918) introduced the system of registering producers and dealers, a system which was extended to the Coconut industry by the Coconut Industry Ordinance (33 of 1923).

The evolution of control in the coffee industry, which started with the above Ordinance, is worthy of special reference since problems peculiar to this industry are involved. These problems are dual. The Colony produces two classes of coffee; a superior quality derived from *C. arabica*, a relatively delicate plant liable when badly cultivated, to disease, and what is commonly known as 'robusta' coffee, of inferior quality and derived from a hardier bush. For market purposes these must be kept apart and, since the plantation industry is based on the former, while the hardier 'robusta' plant is most suited to native cultivation, the question of restriction on the cultivation of coffee by natives became a matter of concern. On this point the Agricultural Commission*, with a view to checking the irresponsible growth of stray groups of plants which would be a source of danger from disease, suggested that the growth of coffee be licensed with a somewhat heavy fee of £10, and that sales should be made through a specified channel. The Coffee Industry Ordinance (54 of 1934), which replaced a like earlier Ordinance (50 of 1932), carried the regulation of the industry further by establishing a Coffee Industry Board as a corporate body with a membership of three officials including the Director of Agriculture, six planters and two representatives of the Coffee Industry Association, financed by a levy on exports of coffee. It would carry this discussion too far from its main thesis to follow the marketing organization with its system of auctions, the appointment of a liquorer† and, later, the formation of an East African Coffee Trades Association, a joint body formed to co-ordinate the industry in the three territories of Kenya, Uganda and Tanganyika.‡ Such steps, however, are complementary to the particular form of tenure and an integral part of the organization if the need for meeting the requirements of the market for quality in the product is to be satisfied.

* Rept. Agric. Commn., Kenya, 1929.
† The Empire Producer, 1936, p. 189.
‡ The Empire Producer, 1937, p. 232.

The last few years have seen a rapid expansion of official control. The Sale of Wheat Ordinance (42 of 1930) licenses millers and controls the trade in wheat with the Kenya Farmers' Association acting as agency; the Tea Ordinance (46 of 1934) licenses growers, limits the area and authorizes inspection by the Director of Agriculture and the collection by him of such returns as he may desire; the Sisal Industry Ordinance (11 of 1934), amended by (12 of 1936), controls the Sisal industry, the former establishing a corporate Committee financed by a levy and grant in aid primarily to develop research, the latter authorizing certificates to growers who accept standard gradings and the use of a standard mark.

Native produce has been handled along the same lines though, as is natural with less reliance placed in private effort. The Kenya Cotton Ordinance (34 of 1923) is a complicated Ordinance empowering the Governor to make rules regulating the kind and quality of seed, organizing seed supplies by methods which include the requisitioning of seed without compensation, controlling method, time and place of growing, ginning, baling and otherwise preparing cotton, inspecting seed and cotton in all stages, licensing and controlling ginning, establishing and regulating markets, prohibiting the export of inferior quality and licensing vendors. It further authorized the prohibition of cotton cultivation or the use of any factory or ginnery in areas declared to be infected. The rules under this Ordinance are administered by the Director of Agriculture and impose a close season. An amending Ordinance (43 of 1931) imposed further restrictions in the control of the movement of cotton and authorized the Director of Agriculture to fix and vary the minimum prices to be paid to natives.

The most comprehensive Ordinance, however, is the Marketing of Native Produce Ordinance (28 of 1935). Section 3 of this Ordinance reads :—

> In the event of the Governor being satisfied that the cultivation and marketing of native produce is likely to be advanced and improved and that the interests of the inhabitants will be generally promoted thereby, it shall be lawful for him to declare any district or part of a district to be an area within which the purchase and sale of native produce which the Governor is authorised to specify in the same or some subsequent order, shall be controlled and regulated.

Section 5 reads :—

> Where the Governor in Council is satisfied that the production of any particular kind of special native produce in any declared area is susceptible of development or would be stimulated and advanced under technical direction and management or other special control, he may, subject to the approval of the Legislative Council signified by Resolution, grant in respect of such area an exclusive trading licence for the particular kind of special native produce, provided that no such licence shall be granted in respect of the produce of husbandry except for the purpose of one or more kinds of special native produce the cultivation or production of which is new to the said area and for which new and improved technical methods of preparation or packing are required.

For the purpose of the first of these sections purchasers are to be licensed, for the purpose of the second, a licence limited to 7 years and subject to renewal by 5 years is to be granted. Rules regulating markets, the location of markets and sales by public auction are to be made by the Governor in Council.

One further Ordinance, the Suppression of Noxious Weeds Ordinance (33 of 1935) remains to be mentioned. It places the onus of report on the owner and authorizes inspection by anyone so nominated in writing by the Director of Agriculture.

(*To be continued.*)

CULTIVATION OF LIME TREES.

THE most suitable situations for limes in Jamaica according to A. P. Hanson* are rich, well sheltered sites from the coast up to 2,000 feet, with an annual rainfall of over 80 inches. Reduced rainfall, low humidity and exposure to wind are detrimental. It is usual to start a young plantation in the shelter of such plants as cassava, sugar-cane, &c., but overhead shade is resented. Any drainage trenching necessary must be done before the young plants are set out. Plants are still usually raised from seed and the method of doing this is described. If budding is resorted to, sour orange should be the stock. Recommended spacing in the plantation :—(*a*) On steep slopes and poorish soil, 12 feet by 12 feet; (*b*) on fairly good flat land, 15 feet by 15 feet; (*c*) on good soil with good rainfall, 18 feet by 18 feet or 20 feet by 20 feet. On a moist land rich in humus an even wider spacing may be advisable. In making the plant holes, which are to be filled with a good compost, it must be remembered that those on clay soils are liable to form water pockets, probably resulting in the plant succumbing to root rot. Such lands should be forked and the compost incorporated so as to form a slight mound. Seedling limes may be expected to bear in the third year after planting, the useful life of a tree being about 30 years. A green manure grown among the trees and periodically cut and used as mulch is markedly beneficial. Pruning consists of removing water shoots and dead branches and removal of weak under branches after the main branches have been formed.

* *Jr. Jamaica Agr. Soc.*, 41, 1937: pp. 427-31.

THE COMPARISON OF FOUR SUGAR-CANE VARIETIES IN TRINIDAD.

By D. D. Paterson and D. M. Hanschell.
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I. Experimental Method.

The experiment consisted of a field trial of four varieties of sugar-cane, namely B.H. (10)12, B. 726, P.O.J. 2878, and Co. 213, each at two different spacings. It was laid down with the object of obtaining an accurate comparison between what are probably the four most popular varieties of cane grown in Trinidad. These varieties were planted at different spacings to ascertain whether there was any advantage to be gained, with any of the four varieties, in using a closer spacing than the normal 5 ft. by 4 ft. between the stools, which is the usual practice in Trinidad.

The experiment was laid down in Field 29 of the College Farm on the usual randomised block principle with five blocks and eight treatments, comprising the four varieties each at two different spacings; namely, the usual 4 ft. × 5 ft. or 20 sq. ft. per stool and the closer 4 ft. × 3 ft. or 12 sq. ft. per stool. In each block there was one plot of each variety, which was divided into two sub-plots, one at the wide spacing and one at the close. The effective sub-plot area was 1/22 of an acre.

The canes were planted in August 1935, after a green manure crop of *Stizolobium* had been ploughed under, and the field had received a dressing of seven tons per acre of pen manure. The soil is of a neutral sandy loam type, with a low nutrient status and would not be considered good cane land in Trinidad. The field received the usual weeding and cultivation, and in October a dressing of 2 cwts. per acre of sulphate of ammonia was applied. The plant-cane crop was reaped in March 1937, in April a second dressing of 2 cwts. per acre of sulphate of ammonia was applied, and the experiment was concluded with the reaping of the first ratoon the following March. In each case harvesting was completed in four days.

Reaping was carried out in the usual manner. The discard rows were cut first, thus forming roadways between the plots. It should be mentioned here that in cutting the plant-cane crop considerable difficulty was experienced in separating one plot from another. An attempt was made to remedy this before cutting the ratoon crop, and for this purpose, bamboo uprights with cross pieces were erected between some of the plots. These however proved to be expensive and did not entirely prevent the overlapping of the canes between adjacent plots. Finally a simpler method was adopted which was to place bamboo poles, 12 ft. in length, at the corners of each plot. These were visible above the tops of the canes, and enabled the cutters to follow the outline of the plots.

II. Varieties.

The Plant-Cane Crop.

Conditions for growth from the time of planting until just before harvest were excellent. Moreover little rain fell during the latter part of February and early March, and the canes ripened well. The plot yields obtained were high, and the mean yields obtained for the four varieties are as follows:

Table I.

Plant-Cane—March, 1937.

Variety.	Yield in tons per acre.
B.H. (10) 12 ...	48.72 ± 2.34
B. 726 ...	48.16 ± 2.34
P.O.J. 2878 ...	36.14 ± 2.34
Co. 213 ...	31.32 ± 2.34

General Mean = 41.08
S.E. of G.M. = ± 5.69%

From these results it can be seen that both B.H. (10) 12. and B. 726 gave significantly better yields than either P.O.J. 2878 or Co. 213, although there was no significant difference between either B.H. (10) 12 and B. 726 or between P.O.J. 2878 and Co. 213.

The juice of the four varieties was analysed by the College Department of Sugar Technology, as each was crushed at the Factory. In order that the analysis might be successfully carried out, it was necessary to reap each variety separately and pass it through the mill as a single unit. The following results were obtained:—

Table II.

Plant-Cane—March, 1937.

Variety.	Tons cane per ton sugar.	Tons sugar per acre.
B. 726 ...	8.506	5.650 ± 0.227
B.H. (10) 12	10.496	4.642 ± 0.227
P.O.J. 2878	11.217	3.220 ± 0.227
Co. 213 ...	12.862	2.435 ± 0.227

General Mean = 3.977
S.E. of G.M. = ± 5.69%
= ± 0.227

The results in Table II show that on the yield of sugar per acre all varieties are significantly different, B. 726 giving the highest yield of sugar per acre, and Co. 213 the lowest.

The results obtained from the different spacings were not significant.

The Ratoon Crop.

The ratoon crop was harvested during the same period as was the plant-cane crop, the previous year. Owing to the exceptionally heavy rainfall during the period prior to harvest, conditions for ripening were poor. The mean yields for the four varieties were as follows :—

Table III.

First Ratoon Crop—March, 1938.

Variety.	Yield in tons per acre.
B.H. (10) 12 ...	21.66 ± 1.009
B. 726 ...	20.95 ± 1.009
P.O.J. 2878 ...	19.99 ± 1.009
Co. 213 ...	16.47 ± 1.009

General Mean = 19.76
S.E. of G.M. = ± 5.11%

The results show B.H. (10) 12, B. 726, and P.O.J. 2878 to be all significantly better than Co. 213, but there is no significant difference between the first three named. As in the previous year, analysis of the juice of the four varieties was again carried out by the Department of Sugar Technology but this year it was possible to extend the analyses so that for each variety, two separate results were obtained, one for the wide spacing and one for the close. The following are the results obtained :—

Table IV.

First Ratoon Crop—March, 1938.

Variety.	Tons cane per ton sugar.	Tons sugar per acre.
B. 726 ...	8.045	2.611 ± 0.107
P.O.J. 2878	9.425	2.120 ± 0.107
B.H. (10) 12	10.820	2.019 ± 0.107
Co. 213 ...	10.125	1.626 ± 0.107

General Mean = 2.094
S.E. of G.M. = ± 5.11%
= ± 0.107

The above results show B. 726 to be again significantly better than any of the three other varieties. B.H. (10) 12 and P.O.J. 2878 are each significantly better than Co. 213, though there is no significant difference between themselves. The results obtained for the two different spacings where again without significance.

Combined Plant-Canes and First Ratoon Crops.

Table V.

Combined Cane Yields of the Plant-Cane and First Ratoon Crops.

Variety.	Yield in tons per acre.
B.H. (10) 12 ...	70.39 ± 3.21
B. 726 ...	69.14 ± 3.21
P.O.J. 2878 ...	56.13 ± 3.21
Co. 213 ...	47.79 ± 3.21

General Mean = 60.86
S.E. of G.M. = ± 5.27%

Table VI.

Combined Sugar Yields of the Plant-Cane and First Ratoon Crops.

Variety.	Tons cane per ton sugar. Mean of two crops.	Total tons sugar per acre.
B. 726 ...	8.405	8.261 ± 0.320
B.H. (10) 12	10.668	6.661 ± 0.320
P.O.J. 2878	10.321	5.340 ± 0.320
Co. 213 ...	11.513	4.061 ± 0.320

General Mean = 6.081
S.E. of G.M. = ± 5.27 %
= ± 0.320

On comparing the combined yields of the four varieties for the plant-cane and first ratoon crops, it can be seen that the two Barbados varieties are both significantly better than either P.O.J. 2878 or Co. 213, but, that there is no significant difference between B. 726 and B.H. (10) 12, nor between P.O.J. 2878 and Co. 213. When however the yield of sugar per acre is used as the basis for comparison, then a significant difference between each of the four varieties becomes apparent; B. 726 giving the highest yield of sugar per acre over the two years, and Co. 213 giving the lowest.

III. Spacing.

As noted above, the results obtained from the different spacings are devoid of significance. Certain observations are, however, worth recording. The yields actually obtained are given below :—

Table VII.

	Tons per acre from	
	Close spacing.	Wide spacing.
Plant-cane crop	42.51	39.63
Ratoon crop	20.13	19.42

As might be expected, it was found that the closer spacing produced a quicker and more effective ground cover than the wide spacing, and consequently the amount of weeding necessary during the growing period was considerably reduced. This saving in the cost of weeding, however, is probably largely counter-balanced by the extra expense in planting and in planting material, which the closer spacing entails. From the point of view of ease of reaping, there appeared to be little difference between the two spacings.

From juice analyses taken from the ratoon crop it is possible to come to some opinion as to how these four varieties respond in quality to the different spacings at which they were planted. Figures were unfortunately only obtained from the ratoon crop.

When these results are considered it can be seen that there is some indication that the closer spacing delays ripening. Although the difference is small when the average of all four varieties is taken, it is more marked in the case of B.H. (10) 12 and Co. 213. With B. 726 the reverse seems to be the case and the closer spacing appears to have produced better ripening. This may possibly be due to the widely spaced plots being overripe at the time of harvest, for B. 726 is recognised as being the earliest ripening of the four varieties. The present data are not sufficient for definite conclusions to be reached, and further experiments are desirable. It would seem that the spacing does in some way affect the ripening of the cane and it is possible that the factor is closely related to the variety of cane and with the date of harvest.

Table VIII.

Tons of Cane to one ton of Sugar : First Ratoon Crop.

	B. 726	B.H. (10) 12	Co. 213	P.O.J. 2878	Mean.
Close spacing ...	7.73	12.06	10.41	9.41	9.90
Wide spacing ...	8.34	9.62	9.92	9.44	9.33

In conclusion the authors wish to express their appreciation to the Department of Sugar Technology for its co-operation throughout the experiment.

Table of Plot Yields for Plant Cane Crop, 1937.

Yields in lbs. per plot. A=Close spacing 4 ft. by 3 ft. B=Wide spacing 4 ft. by 5 ft.

Block.	B.H. 10/12.			B. 726.			Co. 213.			P.O.J. 2878.			Block.
	A.	B.	Total.	A.	B.	Total.	A.	B.	Total.	A.	B.	Total.	Totals.
I	5,489	5,498	10,987	5,802	6,647	12,449	3,186	2,837	6,023	5,803	5,708	11,511	40,970
II	5,234	5,206	10,440	5,473	6,440	11,913	4,485	2,864	7,349	5,253	3,624	8,877	38,579
III	5,102	5,059	10,161	5,260	4,012	9,272	3,519	3,948	7,467	3,042	3,335	6,377	33,277
IV	4,538	5,099	9,637	4,988	4,388	9,376	3,349	2,623	5,972	2,846	2,308	5,154	30,139
V	4,429	3,959	8,388	3,714	2,315	6,029	2,564	2,522	5,086	2,492	2,387	4,879	24,382
	24,792	24,821	49,613	25,237	23,802	49,039	17,103	14,794	31,897	19,436	17,362	36,798	167,347

Table of Plot Yields for Ratoon Crop, 1938.

Block.	B.H. 10/12.			B. 726.			Co. 213.			P.O.J. 2878.			Block.
	A.	B.	Total.	A.	B.	Total.	A.	B.	Total.	A.	B.	Total.	Totals.
I	2,725	2,745	5,470	3,000	3,050	6,050	1,457	1,380	2,837	2,544	2,591	5,135	19,492
II	2,163	2,343	4,506	2,621	2,842	5,463	2,254	1,610	3,864	2,201	2,002	4,203	18,036
III	1,230	1,899	3,129	1,435	1,017	2,452	1,960	1,925	3,885	1,704	2,087	3,791	13,257
IV	2,787	2,149	4,936	2,109	2,044	4,153	1,736	1,621	3,357	2,050	1,867	3,917	16,363
V	2,144	1,875	4,019	1,581	1,641	3,222	1,433	1,394	2,827	1,852	1,458	3,310	13,378
	11,049	11,011	22,060	10,746	10,594	21,340	8,840	7,930	16,770	10,351	10,005	20,356	80,526

THE INFLUENCE OF LIGHT ON SHOOT ELONGATION AND BRANCHING IN *CROTALARIA JUNCEA.*

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and R. S. Choudhri, M.Sc.

During a general investigation on the influence of light on crop plants at this Experiment Station, it was noticed that light had a marked effect on the rate of elongation and of branching in *Crotalaria juncea* (Indian hemp). Since fibre length is a characteristic of great technical importance, we have carried out more detailed studies on the effect of variation in the daily period of illumination on this plant, the results of which are presented in this article.

Plants were grown from a pure line seed, locally selected, in containers filled with a mixture of soil and manure. Several seeds were sown in each pot, but the seedlings were thinned to one per pot to leave seedlings of uniform vigour. Soil pH was maintained at 6.5 and the saturation limit at 22 ± 1 per cent. The plants were divided into fifteen groups, each group being given a different daily period of illumination. These photoperiods ranged from zero to continuous light. In order to guard against the possibility of variation in the plants caused by different *intensities* of light, sunlight was supplemented by the use of electric light of 80,000 m.c. intensity, a value which previous experiments have shown to be well above the limiting intensity. The plants were examined at successive stages throughout their life cycle, but only the results for 14 weeks old plants (except those growing in darkness and one hour daily light*) are here recorded.

The results are shown graphically in the form of smoothed curves in Fig. 1., one curve representing length of the shoot and the other the number of branches under different daily periods of illumination, each being expressed as a percentage of the value for 12 hours. This particular photoperiod is taken as the standard because the plants grown in it most closely resembled normal plants. It will be noted that increasing illumination caused a rapid increase in the shoot length until a photoperiod similar to normal daylight was reached, and that photoperiods above this value caused much smaller increases. Similarly, increasing illumination up to normality caused the plants to develop more branches, but with longer daily periods there was a rapid decline in the number, so that with 18 hours daily illumination or over, no branches at all were found.

These results suggest that with photoperiods of less than 12 hours, both elongation and branching are retarded because the duration of the light is insufficient for optimum growth, but that above this period, there is a pronounced specific effect on branching. The small further elongation as the photoperiod is increased beyond 12 hours is no doubt related to the suppression of branching, probably because the materials for growth are no longer diverted to branches, but remain in the main stem.

In conclusion, then, the production of high class fibre would appear to be favoured by long days and it is suggested that latitude and season should be taken into consideration when the cultivation of *Crotalaria* for fibre purposes is projected.

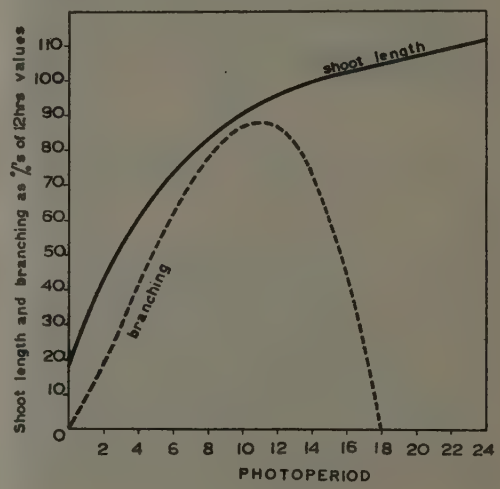


FIG. 1

* Plants belonging to these two groups died after two and six weeks respectively and therefore, the observations in the two cases could be recorded at such stages alone.

ERADICATION OF LALANG GRASS.

In an article on "The Use of Chemicals for the Eradication of Lalang Grass (*Imperata arundinacea*)", J. L. Greig* states that this grass has recently been extirpated at the Serdang Experiment Station during both the wet and the dry seasons by spraying with 10 lb. sodium arsenate to 55-60 gallons of water per acre at 7-day intervals. Control was obtained in from 5-10 sprayings. The soil was able to support self-sown weeds almost immediately and trees growing on the sites were uninjured. Sodium chlorate proved ineffective. The cost under suitable conditions should be 25 dollars (Straits) per acre, as against 40 to 50 dollars, the cost of hand digging.

* *Malay Agr. Jr.*, XXV, 1937, pp. 363-9.

THE DETERIORATION OF HARVESTED SUGAR-CANE.

Some Experimental Studies in Egypt.

By Arthur H. Rosenfeld.
(*Govt. Sugar-Cane Technologist.*)

It is in times of stress and low prices such as the world's sugar industry has been experiencing for the past decade that the question of economy of production assumes even greater importance with the hard-pressed planter than the actual stepping up of his per-acre yields. Manifestly, if he can maintain his standard of production while economising 10 per cent. in his costs or in avoiding hitherto unattended losses, he has accomplished even more than by increasing his yield by a comparative percentage. Manifestly, too, if after making and harvesting an excellent crop, he allows that very agency which has largely made his good crop possible — sunshine — to carry off by evaporation 10 per cent. of his tonnage, he has lost not 10 per cent., but very probably *all of the potential profits* from his year's work.

One of the phases of the otherwise very efficient Egyptian cane harvest which has most impressed the writer is the enormous unrecognized loss by evaporation and deterioration often suffered by the planter and, during the crop of 1934, it was decided, in co-operation with Manager Demulling of the Abu Kurgas Sugar Factory near Mallawi, to attempt to determine what these losses would be under determined conditions—not only to the planter, but also to the factory handling his cane, since in the general economy of the Egyptian sugar industry the two are inextricably interrelated.

The following procedure was carried out in four distinct series of tests on the Government Farm at Mallawi, commencing on 15th and 30th March and 10th and 20th April, respectively, to establish the losses in both field and factory, under the climatic conditions of each of these periods, when cut cane is left in the field for periods ranging from one to eight days.

On the morning of the first day of each experimental series, some two tons of *P.O.J.* 105 cane were cut and stripped in the usual manner for the factory. Nine lots of exactly 200 kilograms each were then weighed out and the number of canes in each lot recorded for checking as each lot was weighed on successive days, in order to be sure that any loss of weight might not be due to pilferage, although special *ghaffirs* were assigned to guard this cane. The first lot was immediately despatched to the factory, in a locked box especially constructed on a lorry, for analysis. The remaining lots, numbered from 1 to 8 respectively, were then separately spread out over a clean, dry area in the field so as to be exposed to the action of sun and wind just as they would be ordinarily in a harvested field, care even being taken to have the canes aligned from north to south in accordance with the orientation of the majority of the cane at the loading stations. This precaution was taken because it has been observed that most of the investigators (3, 4, 7, 9) of the drying-out and deterioration of cane have placed their lots of cane either in relatively large piles—and sometimes under cover—or on railroad vans, where the action of both temperature and wind, as well as atmospheric dryness, is largely masked. As the writer (25, 26) has frequently observed, there is not the least doubt that cane will evaporate and deteriorate much less rapidly if kept on cars, particularly in the shade, or in large piles, than it will when spread out normally over the field.*

At nine o'clock each morning for the following eight days, lots 1 to 8 were successively counted and weighed and despatched in the lorry box to Abu Kurgas for analysis, with the results shown in Table I. A record was kept of the maximum and minimum temperatures during the course of

* A striking illustration of this almost axiomatic fact is afforded by an article by Haldane (16) in which he discusses the effect of delayed milling in a large amount of cane stored in the yard of an Upper Indian sugar mill, the operation of which was interrupted for two weeks as a result of the disastrous Bihar earthquake of 15th January, 1934. The cane supplies at this factory when the earthquake caused the stoppage were some 960 tons. During the 14-day delay, daily analyses were made of the stored cane and when the factory was again able to start operations, it was carefully re-weighed before crushing, showing a loss of only just under 8 per cent. in weight. Meanwhile the sugar per cent. cane (*Richesse*) had fallen by only $1\frac{3}{4}$ units and the juice purity by but 9 points. "A greater deterioration", says Haldane, "would undoubtedly have been noted had the bulk of the stored cane not consisted of *Co.* 213, a variety which does not deteriorate as rapidly as other Coimbatore or indigenous varieties; thus a small percentage of the supplies consisted of *Co.* 205, a variety well-known to deteriorate rapidly and an analysis of this cane on . . . 29th January gave a purity of 63.29 as compared with . . . 76 for *Co.* 213. Further, as in drying-out, the low temperatures experienced during the storage period have played an important rôle in minimising the rate of deterioration".

The kilograms of sugar recovered per ton of cane only dropped during this period from 110 to 86, the present writer being convinced that, despite handling a relatively slowly inverting variety in quite cold weather (the records maintained at the Central Control Laboratory of Messrs. Begg, Sutherland & Co., Ltd., gave an average maximum and minimum temperature and relative humidity of 20°C, 8°C and 57 per cent. respectively, the absolute maximum being $24\frac{1}{2}$°C and the lowest minimum $4\frac{1}{2}$°C), this loss, as well as that in weight and juice purity, would have been at least doubled had the cane been left scattered over the fields instead of being stored in the mill yard.

each series of tests. It will be noticed in the table that only the maximum temperatures are recorded and a question may arise in the minds of some readers as to why this is the case. Quoting Agee and Das (2). "After all we are not using maximum temperature as a thing itself; we are merely employing it as an index of something else that has taken place. Any record of air temperature, however precise, would fail to offer us an exact expression of the thing we are trying to evaluate. The most we can hope for is an index." Maximum temperature has been found to give better correlation than mean temperatures in plant life studies by many investigators, of whom the conclusions of Pearson (20) may be considered as typical: "In conclusion I wish to recommend to ecologists that they consider the mean maximum temperature . . . Obviously, the mean maximum is to be regarded only as an index rather than a complete measure of heat conditions. To Weather Bureau officials I wish to suggest that they include the mean maximum in their temperature summaries."

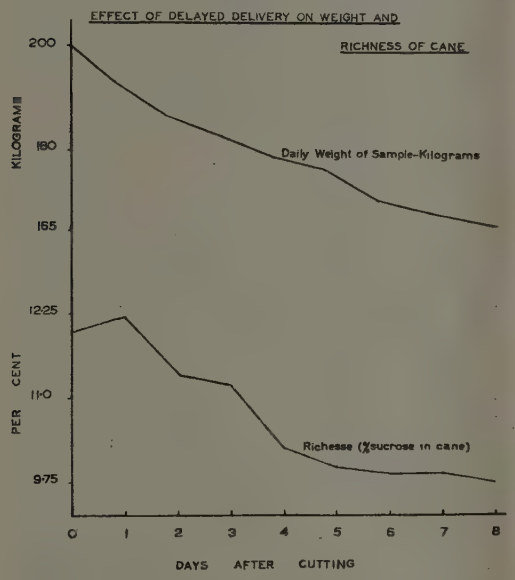
TABLE I.

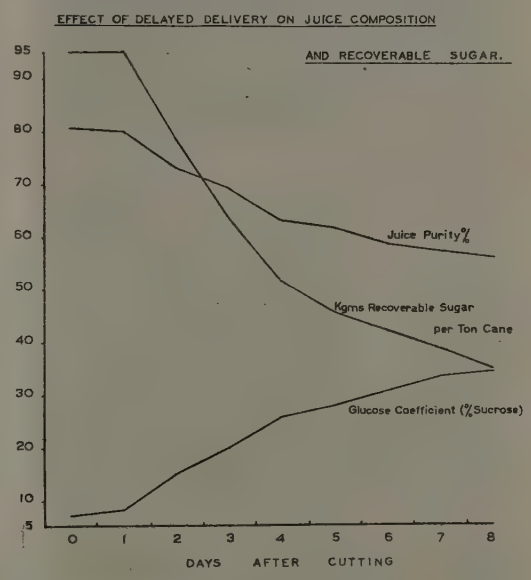
Mallawi Evaporation and Deterioration Tests.

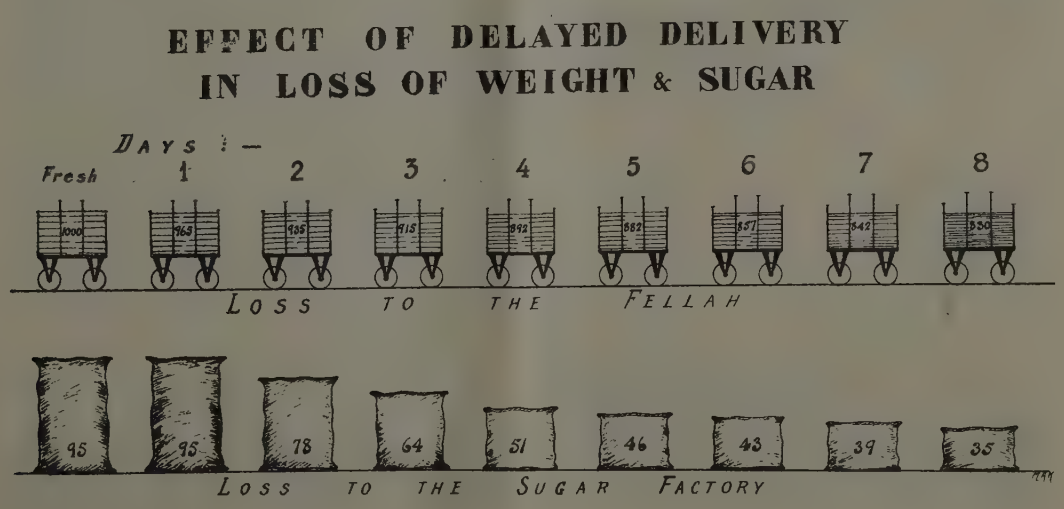
	Days after Harvest.									
	0	1	2	3	4	5	6	7	8	Total Drop.
I.—Experiment starting 15th March, 1934.										
Weight of Sample—Kgms.	200	193	190	186	184	182.5	177.5	174.5	173	27 (13.5%)
Purity of Juice—%	77.2	75.7	71.4	71.0	65.7	60.0	55.6	55.7	53.1	24.1
Glucose Ratio—%	11.0	12.5	18.2	18.4	18.6	26.2	27.2	30.3	30.3	* 19.3
Richesse (Sucrose in Cane)—%	10.78	10.79	10.15	11.06	10.47	9.36	9.03	9.01	8.64	2.14
Kgms. Recov. Sugar per ton Cane....	85	83	74	74	60	43	38	35	28	57
Max. Temp.—Deg. Cen.	30	34	33	29	28	28	29	28	31	30 (Ave.)
II.—Experiment starting 30th March, 1934.										
Weight of Sample—Kgms.	200	193	189	185	181	178	175	172.5	169.5	30.5(15.25%)
Purity of Juice—%	82.4	81.7	73.7	69.8	63.1	64.6	61.1	63.0	58.9	23.5
Glucose Ratio—%	5.1	6.6	16.6	22.4	28.3	29.7	29.8	30.3	31.5	* 26.4
Richesse (Sucrose in Cane)—%	12.32	12.45	11.83	11.65	10.62	11.01	10.60	11.02	10.35	1.97
Kgms. Recov. Sugar per ton Cane....	98	98	77	68	55	55	51	51	41	57
Max. Temp.—Deg. Cen.	30	28	36*	35	32	30	35	29	29	31.5 (Ave.)
III.—Experiment starting 10th April, 1934.										
Weight of Sample—Kgms.	200	192	180	176	170	148	165.5	162	161.5	38.5(19.25%)
Purity of Juice—%	81.2	79.5	72.6	63.6	62.1	61.2	61.0	56.8	57.3	23.9
Glucose Ratio—%	6.3	8.2	14.5	24.0	27.0	27.5	28.1	33.5	33.5	* 27.2
Richesse (Sucrose in Cane)—%	12.50	12.26	11.58	10.22	10.37	10.53	10.52	10.48	10.55	1.95
Kgms. Recov. Sugar per ton Cane....	99	96	75	50	47	46	46	43	43	56
Max. Temp.—Deg. Cen.	35	36	32	30	28	28	30	29	27	30.6 (Ave.)
IV.—Experiment starting 20th April, 1934.										
Weight of Sample—Kgms.	200	194	190	184	179	178	168	166	160	40 (20%)
Purity of Juice—%	81.4	83.6	76.9	71.2	60.5	59.7	57.2	52.9	55.3	26.1
Glucose Ratio—%	6.0	6.6	10.9	15.9	29.4	29.6	38.3	40.2	42.1	* 36.1
Richesse (Sucrose in Cane)—%	12.27	13.25	11.91	11.81	9.57	9.12	9.31	9.25	9.47	2.80
Kgms. Recov. Sugar per ton Cane....	98	105	86	72	41	38	35	28	28	70
Max. Temp.—Deg. Cen.	28	27	26	29	33	36	39	38	39	33 (Ave.)
Average of the four experiments.										
Weight of Sample—Kgms.	200	193	187	183	178.5	176.5	171.5	168.5	166	34 (17%)
Purity of Juice—%	80.6	80.1	73.7	68.9	62.9	61.4	58.7	57.1	56.2	24.4
Glucose Ratio—%	7.1	8.5	15.0	20.2	25.8	28.3	30.9	33.6	34.4	* 27.3
Richesse (Sucrose in Cane)—%	11.97	12.19	11.37	11.19	10.24	10.00	9.87	9.94	9.75	2.22
Kgms. Revoc. Sugar per ton Cane....	95	95	78	64	51	46	43	39	35	60

* *Khamsin* from 8 a.m. (sand storm and hot south wind).

At best, air temperatures can be but a value correlated in some way with hour-by-hour stalk temperature, for it is within the cane stalk, under the temperature of that stalk, that chemical reactions take place which are to assert themselves in the change of form of the carbohydrates therein which are involved in the phenomenon of deterioration, while increased heat, in combination with varying conditiins of humidity and air movement, must inevitably intensify evaporation. Mean temperatures—and minimums to an even lesser degree—afford practically no co-ordination whatever with deterioration studies for the obvious reason that there is practically no chemical or biological activity in the cane stalk at temperatures anywhere below about 11°C. Hence, deterioration becomes practically stationary just above that temperature, but is cumulatively speeded up as the temperature rises—particularly as the higher temperatures are maintained for longer periods, although there are so many factors involved in cane deterioration (5, 6, 8, 13, 17) that the effect of a definite number of *effective* hour-degrees on the sucrose or invert sugar content of the cane can hardly be accurately measured. While the effect of heat is operative, other factors, such as humidity and juice concentration as a result of evaporation, are contributing to the process, so that the exact effect of heat alone on the recoverable sugar in the cane can be only approximately predicted (19, 22). The effects of both heat and humidity on cell turgidity are also important and little understood.







Only rather general correlations, therefore, may be attempted from the figures in Table I. Studying the results of the successive series of tests it will be noted that there is a progressive increase in the loss by evaporation and in the glucose coefficient as the hours of sunshine became longer and the periods of duration of the higher temperatures were lengthened also, undoubtedly, as the relative atmospheric humidity became reduced.* It is highly significant, also, that, comparing the final results from the 1st March series of tests, during which the average maximum temperature was 30°C, with the last April series, with an average maximum three degrees higher, not only has the cane in the latter series lost 20 per cent. of its weight by evaporation against only 13½ per cent. for the earlier lot, with a corresponding increased drop in sucrose content and purity, but the coefficient of glucose has increased to 36.1 per cent. against only 19.3 per cent. and—most important of all—the final series has lost 70 kilograms of the recoverable sugar per ton of cane against a sufficiently serious loss of 57 kilograms in the earlier series.

It is only in the early days of each series that any direct result of higher or lower maximums can apparently be traced, since the effects of the various factors causing deterioration become cumulative and intermixed as the process proceeds. If we examine the maximum temperatures for the day each series was cut, we find that the maximum for the first two series was 30°C, that for the third series was 35°C and that for the final series was but 28°C. If we average the figures for the first two series with the maximum at 30°C and compare the figures for the series beginning with 35°C maximum and 28°C maximum, we get the very consistent trend shown in Table II.

TABLE II.

Evaporation and Deterioration during First Day of Each Series.

	Maximum temperature in degrees centigrade.		
	28	30	35
Loss in Weight—Kgs.	6	7	8
Drop in Purity—Percentage Points ...	0.8	1.1	1.7
Rise in Gluc. Rat.—Percentage Points ...	0.6	1.5	1.9
Drop in *Richesse*—Percentage Points ...	+ 0.98	+ 0.07	0.24
Loss of Recov. Sug. p. Tn. Cane—Kgs. ...	+ 7	1	3

* According to the Egyptian Meteorological Service (Ministry of Finance Almanac) the following figures represent the average daily relative humidity at Assyut, showing a progressive drop for the first half of the year. Jan. 70 per cent., Feb. 64 per cent., March 55 per cent., April 44 per cent., May and June 38 per cent.

Just as in the case of the Louisiana experiments by Lauritzen and Balch (18), there was no significant change in acidity, pH or organic non-sugars that indicated the action of micro-organisms in the deterioration of the cane during these experiments. Also, the inversion of sucrose seems to be closely related with moisture losses, maturity and reduced turgidity of the cane, increasing with the drying-out of the latter and becoming slower as the cane reaches successively higher stages of maturity.

Examining the average results for the four experiments, it will be noted that the planter lost 3½ per cent. of his cane weight the first day, 3 per cent. the second, 2 per cent. each on the third and fourth and an average of 1½ per cent. on each of the final four days, the average daily loss in weight for the period being slightly over 2 per cent. Of the total loss of 17 per cent. in weight, however, it should be noted that about two-thirds (10.75 per cent.) occurred in the first four days, a period over which cane deliveries are not infrequently delayed in Upper Egypt.

The average daily drop in purity has been just over three points, that for the first day being negligible, while for each of the following three days it averages close to 6 points. After that the rate of purity loss drops to a daily average of about 1.7 per cent. almost three-quarters (17.7 points) of the total purity drop of 24.4 points having taken place in the first four days.

The increase in the vitally important invert sugar coefficient has again been negligible for the first day, but is 6½ points for the second day and over 5 points each for the third and fourth. After that it ascends at a daily rate of around 2 per cent. The average increase has been at the rate of about 3½ points per day, over two-thirds (18.7 points) of the total rise of 27.3 points having been reached by the fourth day.

As regards the final out-turn in kilograms of sugar recovered per ton of cane ground, there is no factory loss whatsoever during the first day's delay, due to the already mentioned concentration of the juice as a result of evaporation of water. However the losses in recovery for the second, third and fourth days respectively were the very high ones of 17, 14 and 13 kilograms of sugar, respectively, per ton of cane. After that the average daily loss is at the rate of four kilograms per day, only 35 kilograms of sugar being recoverable on the eighth day as compared to the 95 kilograms extracted from each ton of fresh cane—*a loss of almost two-thirds of the sugar originally recoverable*! 44 kilograms, or almost three-fourths of the 60 kilograms of recoverable sugar per ton of cane lost during the eight-day period, had disappeared on the fourth day.

Summing up, then, it appears that the Egyptian fellah who delays delivery of his cut cane during March and April may expect a loss of weight—and hence of the returns from his crop—of about 3½ per cent. after one days' delay, 6½ per cent. after two, 8½ per cent. after three and close to 11 per cent. after four days of delay, while the sugar factory must

count on recovering some 17 kilograms less sugar per ton of cane when deliveries are delayed two days, 31 kilograms after three days and 44 kilograms less if deliveries are made as late as four days after cutting. These are striking losses indeed, particularly when it is realized that they are largely preventable by efficient organization of harvesting and loading operations.

It should be emphasized, also, as regards the drop in recoverable sugar per ton of cane, that the unrecovered sugar which leaves the factory in the final molasses does not represent the only loss to the factory handling deteriorated juices, since these cause the slowing down—and, therefore, increase the expense—of all phases of fabrication. Inverted juices are more difficult to defecate, filter and boil than fresh ones and the lengthening of those processes inevitably results in a costly reduction in factory capacity while old cane is being handled and a consequent increase in overhead expense per ton of cane or sugar.

Some Comparable Experiments in India.

The striking losses of both weight of cane and recoverable sugar indicated by the Mallawi experiments are higher than those published by some previous investigators in Egypt and other sugar countries—due largely, as already pointed out, to the fact that the cane in previous experiments was generally kept in rather large piles in the field or actually under a roof, thus reducing the intensity of the effects of heat, dryness and air movement as normally exerted on cut cane left scattered over a field or *wahsa* (loading station). Many of those experiments (10, 11, 23, 28), in fact, were conducted in order to demonstrate that drying-out and deterioration in cut cane can be lessened by storage of cane in large piles or on cars, by shading, moistening, &c.—a phase which will be briefly dealt with, in the case of *force majeure*, in the following section. Some earlier trials, too, like those of Pellet in Egypt (21), were conducted during the coldest period of crop, when deterioration is at its *nadir* (lowest). It should be remembered, too, that the peculiar climatic conditions during the cane harvest in Upper Egypt are probably found in no other cane-producing country except certain districts in Upper India, where cane is harvested about the same time as in Egypt, where high daily-sunshine percentages and low atmospheric humidity are similar to our own and where the hot west winds, which commonly blow from the beginning of March onwards till the break of the monsoon in the latter part of June, exert a similar influence on the drying-out of cane to that of our familiar *Khamsins*, in March and April. Even the daily temperature ranges in the two countries are very comparable, as indicated by the fact that the Central Control Laboratory of Messrs. Begg, Sutherland & Co., Ltd., gives the average maximum temperature in March and April in the Saran district of Behar province as 31.5°C and 36.5°C respectively, which are slightly higher than the average maximums of 30°C recorded during our first March experiment and 33°C during our final April test. Relative humidities are even lower in those districts during the crop months than in Egypt, as may be seen from the following figures.

TABLE III.

Relative Humidity.	Assyut, Egypt.	Marhowrah, India.
January	70	61
February	64	56
March	55	35
April	44	29

One would, therefore, expect a rather higher rate of drying-out and deterioration in cane harvested in the Upper Indian districts than in Upper Egypt at comparable dates. Hence, it is of peculiar interest to study the results of some very carefully conducted drying-out and deterioration experiments (in the Champaran, Darbhanga, Saran and Gorakhpore districts of Upper India) which have been reported by Haldane (15), particularly as they were conducted along lines very similar in every way to our own trials at Mallawi. Seven of the principal varieties of cane grown in these areas were used in the total of 85 tests conducted during January, February and March, 1933, ninety average stalks being the basis of each experiment, which ran

TABLE IV.
Comparative Results in Egypt and India.

Days after Harvest.	Country.	0	1	2	3	4	5	Total Drop.
Loss of Weight—per cent. Original	Egypt	—	3.50	6.50	8.50	10.75	11.75	—
	India	—	3.70	6.50	8.94	11.31	14.59	—
Units Decrease in Purity	Egypt	—	0.50	6.90	11.70	17.70	19.20	—
	India	—	2.42	6.60	15.02	19.61	24.87	—
Kgs. Recov. Sugar per ton Cane	Egypt	95	95	78	64	51	46	49
	India	117	114	102	87	78	66	51

for five days—about the limit at which old cane would be accepted at any factory. In Table IV are given the average results for the seven varieties, compared for convenience with the average results for the first five days in the Mallawi tests.

The similarity of the trends in the two general series of tests is manifest throughout and serves to emphasize Dr. Haldane's conclusion that the losses due to delayed deliveries are of such dimensions as to warrant serious consideration by growers and millers alike.*

The Reduction of Drying-out and Deterioration in Emergencies.

While every grower should plan to deliver his cane to the sugar mill just as promptly as is possible—and never later than 48 hours after cutting if he wishes to avoid profit-absorbing losses of a very serious nature (24)—there occasionally arise, due to a breakdown at the factory, a wreck on the railroad, the collapse of a bridge on his branch railway or other unpredictable mishap, conditions under which he finds himself with a relatively large amount of harvested cane which it is impossible to have ground for several days. The question then immediately arises as to the possibility of taking some steps to minimise his losses during this period of enforced stoppage of deliveries. Fortunately, it is quite practicable to reduce materially such losses if he will employ prompt measures to mitigate the inimical effects of heat, dryness and air movement on the cut cane. If vans are available, the cane should be promptly loaded thereon and covered at the top with cane leaves and trash. If railway trucks are not available, the cane should be collected in large piles and immediately covered with leaves and trash, in order to eliminate direct sunlight, conserve moisture and obviate the desiccating effects of high winds. If the field is so located that water may frequently be thrown over the covered piles of cane, drying-out and deterioration may be still more materially lessened.

In Java as early as 1894, Prinsen Geerligs and Went (23) found that sound canes cut from the field remained practically unchanged for five days if covered with moist sheets and in Louisiana the following year Stubbs (29) showed that fresh-cut cane *immediately* covered with leaves and trash could be left in the field for a considerable period of *cold* weather without material loss. Again, in Java at the turn of the century, Müller von Czernicky (11) demonstrated that cane stored in a closed room for five days lost only twelve points in purity, while cane left one day in the field after cutting and then stored for five days in the same room lost over twenty points, his observations being confirmed by Savornin Lohman (28). As a result of these investigations, cut canes in Java are today immediately covered with leaves and trash—if possible moistened—when any breakdown in the mill or other mishap may cause a delay in its milling (12).

* Also *vide* Scott, W. (1926) *Tropical Agriculture*, III, 2, p.34.

In the Argentine, Cross and Belile (10) demonstrated by extensive experiments in 1914 that drying-out and deterioration of cut cane can be materially reduced by such measures and in 1920 Krishnamurthy Rao in India showed that Prinsen Geerligs and Went's experimental results were applicable to India. Recently (14) it was shown in India that freshly cut canes wrapped in moist straw or cane trash may be kept for five days without material drying-out or deterioration. In Louisiana in 1929 the present writer (26, 27) emphasized very strongly that cane will evaporate and deteriorate at a much reduced rate if kept in vans or large piles, especially in the shade, as compared to leaving it spread over the fields and exposed to sun and air movement.* Finally, during the past few years, Lauritzen and Balch (18) have investigated the question of cane storage in Louisiana very carefully and the following conclusions arrived at by them should serve to reinforce strongly the recommendations at the commencement of this section: "The results show conclusively that the sprinkling of cane in small piles prevents heavy losses of sucrose in all varieties . . . that very little deterioration occurred in stored sugar-cane when it was kept thoroughly wet during the period of storage . . . The results also indicate that shading the stored cane, especially during dry weather, tends to furnish further protection against deterioration."

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* J. F. Williams (32) states that in Demerara greater losses are found to occur when the cut cane is exposed to the sun than when kept covered. "This should be borne in mind when punt loads of cane have to be kept some time in the factory dock."

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MINOR ELEMENTS.

[*The following article is taken from the "Report on the Progress of Applied Chemistry" for* 1937, *Vol. XXII, issued by the Society of Chemical Industry, London. It appears in the Section on Soils and Fertilisers, pp.* 585-589, *written by Dr. E. M. Crowther, of the Rothamsted Experimental Station.*—ED.]

THE literature on minor elements in soils in relation to nutritional deficiencies in plants continues to grow rapidly. Already it is clear that deficiencies of manganese and boron (which appear at present to be the most widespread) may arise not only from absolute shortage of the elements in the soil, but also through the effects of other factors of soil composition, treatment, or climate in restricting the availability to plants of compounds of these elements. Thus, "heart-rot" in sugar-beet, caused by boron deficiency, was particularly severe throughout Europe in the dry years 1934 and 1935, but not in the wet year, 1936. *Manganese* deficiencies occur very frequently on light soils rich in humus, *e.g.*, reclaimed heaths, which have been made alkaline by excessive liming. *Boron* deficiencies may also be brought about by over-liming. An example is given in recent pot cultures by J. A. Naftel on a Norfolk loamy-sand. Overliming caused severe injury to vetches, turnips, oats, cabbage, tomatoes, and soya beans, amounting sometimes to virtual crop failures. Addition of small amounts of boron prevented any harmful effects from overliming, but addition of manganese had no effect. The conversion of exchangeable manganese into comparatively insoluble oxides might explain the lack of available manganese in certain alkaline or heavily-limed soils, but there is no such simple method of accounting for the lack of available boron in such soils. E. V. Bobko and his colleagues have suggested that liming may lead to a great increase in the microflora, which might lock up the readily soluble boron.

Already the minor elements are presenting problems of solubility and availability which are comparable in complexity and practical importance with those for the major nutrient elements. The fact that on certain classes of soil overliming may lead to crop failures makes these problems particularly important at a time when organised liming campaigns are being conducted in many countries. The relationship of "grey-speck" disease of oats to the readily-soluble manganese and other soil factors has been studied for a large number of Danish soils by F. Steenbjerg, who used the manganese contents of successive leachings with magnesium nitrate to extrapolate to the total exchangeable manganese of the soil, and to obtain an expression for the firmness with which the manganese is held. He showed that "grey-speck" occurred in 95 per cent. of the soils with less than 0.5 mg. exchangeable manganese per kg., but only in 5 per cent. of the soils with more than 2 mg. per kg. From the exchangeable manganese, the pH, and the buffer capacity, he developed an empirical expression to show how much lime might safely be used without appreciable risk of injuring the crop.

In certain Australian soils, W. G. Leeper found that manganese-deficient soils could be detected more readily by the amount of manganese extracted by an ammonium acetate solution containing quinol (to reduce oxides) than by the ammonium acetate alone. A characteristic disease of pea seeds in the Romney Marsh area of Kent appears to involve manganese deficiency. B. S. Furneaux and H. H. Glasscock showed by soil-survey methods that the disease was most common on certain heavy soils with relatively high water-tables. S. G. Heintze showed from a set of soils taken in this survey that the disease did not occur on acidic soils, and that the exchangeable manganese was very low on the

alkaline soils which carried affected peas, even though the soils often contain appreciable amounts of oxides of manganese. She was able to control the disease by adding manganese salts to soils in pot cultures. There is no clear understanding of the cause of "grey-speck" in oats or of the rôle of manganese in plants, though guesses and odd observations are not lacking. A few years ago, M. Popp obtained the puzzling result in pot cultures on manganese-deficient soils that an excess of slaked lime allowed oats to grow without "grey-speck" disease. This has been ascribed to a form of "partial sterilisation." F. C. Gerretsen elaborated an argument which involved, not only manganese shortage, but an attack on the plant roots by bacteria, the products of which spread through the plant and caused the characteristic spots. Adequate manganese supplies were supposed to enable the plant to resist invasion by the bacteria. These bacteria were not, however, isolated, and the methods of sterilising soils by small amounts of formaldehyde seem to have been quite inadequate for their purpose, though they may have affected the the solubility of the soil manganese.

In New Zealand, boron has been used successfully for controlling "internal cork of apples", when broadcast over the soil at the rate of 50-100 lb. per acre or 0.5-1.01 lb. per tree. The boron penetrated to 18-inches depth, and the fruit on treated soils had the same boron content as healthy fruit. The borax could also be applied successfully by injection or by spraying with a 0.25 per cent. solution.

Marsh soils suffering from "reclamation sickness" were found to contain less than 2.5 mg. of *copper* per kg., as compared with up to 10 mg. per kg. in healthy soils. The low copper contents were ascribed to the removal of soluble copper as sulphide by bacteria, producing hydrogen sulphide. Very small amounts of copper in soils were detected by the appearance of cultures of *Aspergillus niger*. A. O. Alben and H. M. Boggs showed that Pecan rosette, which is associated with *zinc* deficiency, may occur on alkaline soils containing considerable amounts of zinc, though it is not found on acidic soils with only moderate zinc contents. To check the declining yields of of irrigated citrus trees, which are ascribed to the effect of alkalinity on the solubility of copper, manganese, iron, and zinc, W. T. McGeorge proposes to spray the chlorotic foliage with iron or zinc salts, to treat the soil with sulphur, and to irrigate with slightly aciduated water.

The United States Bureau of Chemistry and Soils has given data for the contents of selenium, arsenic, copper, cobalt, nickel, zinc, barium, chromium, vanadium, and molybdenum in a number of profiles from the chain of Erosion Experiment Stations, and has shown that these elements are very widely distributed, and occur in individual profiles in accordance with the nature of the soil-forming processes. It has been known for some years that "bush sickness" in sheep in parts of the South Island of New Zealand could be controlled by drenching the sheep with suspension or with dilute acidic extracts of certain healthy soils or, again, by some forms of limonite. There were, however, some anomalous observations, such as the failure of some limonites. These now appear to have been largely explained by the discovery that very small amounts of *cobalt* (8 mg. weekly) are also effective in controlling the disease. The cobalt content of New Zealand soils varies very widely, the extremes being 0.3 to 380 parts per million. Bush sickness was frequently associated with very low contents, and the soils used successfully in drenches were relatively rich in cobalt. A few anomalies still remain, and it has not yet proved possible to remove these by taking the readily-soluble cobalt as the index of availability. Application of cobalt chloride increased the cobalt content of the herbage, though heavy dressings were toxic. Superphosphate facilitated, and lime depressed, the uptake of cobalt by plants. Preliminary investigations in this country have shown that some Dartmoor soils, on which a form of pining occurs in sheep, also have very little cobalt, whilst healthy "change pastures" are much richer.

The discovery that certain South Dakota soils contained sufficient *selenium* to yield plants toxic to animals has led to active work on this element in soils and plants. In Hawaii, selenium appears to be derived from volcanic gases and sublimates, and to be carried into the soil by rain and held as a highly insoluble basic iron selenite. In soils which are not highly ferruginous, calcium selenates may occur, and the water-soluble selenium may then exceed 0.1 part per million ; in very saline soils there may also be organic selenium compounds. The absorption of selenium by plants appears to follow their sulphur requirements. Although in pot cultures, treating soils containing 2 parts of selenium per million with sulphur or sulphates lowered the concentration of selenium in the wheat grown and prevented any toxic effect of the grain on the rats, field experiments with dressings of gypsum up to 1,500 lb. per acre failed to cause any material reduction of the selenium contents of the crops. The selenium of toxic cereal grain is present in the protein fraction, and on hydrolysis of wheat-gluten, passes into the leucine fraction. The fact that selenium possesses the unique property of being more poisonous to animals than to plants opens up some interesting possibilities in producing poisoned plants as insect traps. T. G. Mason and E. Phillis found that small amounts of sodium selenate added to culture solutions of cotton plants killed cotton-stainers feeding on the green bolls.

In the "grey wooded soils" of Alberta, Canada, clovers responded to additions of *sulphates* as ammonium sulphate, gypsum, or the "alkali" salts from the prairies. In France, rapidly growing cruciferous crops may respond to sulphur as sulphates, given as a supplement to farmyard manure ; seaweeds and various marine slimes may be also used as sources of sulphur. On the other hand, G. Bertrand's analyses of the sulphate contents of rain water show that this alone should be nearly sufficient to meet the requirements of most of the crops grown in France.

PRACTICAL ASPECTS OF COPRA DETERIORATION.*

In this paper Mr. Cooke has dealt with all the practical aspects of quality in copra. The entomological and mycological aspects of the same subject have been dealt with in Special Bulletin, Scientific Series, No. 20 of the Department of Agriculture, S.S. and F.M.S.

There is no real reason why bad copra should be produced anywhere in the world for, apart from very slight differences in oil content in the nuts of different countries, the quality of the meat is the same in all ripe coconuts from healthy palms all over the world. Differences in quality are due only to differences in care in the preparation of the copra and its subsequent handling, and it calls for no great amount of care, no high technical knowledge and no great expense, to prepare very good copra. For years the Departments of Agriculture of all copra-producing countries have been trying to educate local producers to prepare good copra, and to induce local traders to encourage its production. Yet even today the general standard of quality of the world's copra is appallingly low in comparison with the standards of every other primary agricultural produce that enters into world trade.

Undoubtedly one factor that contributes to this is the fact, explained by Mr. Cooke (pp. 26 and 27) that as copra deteriorates, while its oil becomes more acid, while moulds destroy its substance, it unfortunately happens that simultaneously the oil content of the remainder rises. Thus, though deterioration involves loss of weight and loss of quality in the oil and in the cake, yet no decrease—even a slight increase—occurs in the first figure the buyer looks at—the oil content of the sample.

This fact, however, does not entirely explain the present unsatisfactory condition of the world's copra, for despite it, the miller of copra is prepared to pay more for good copra than for bad. The higher value of the good oil and cake that he can make from good copra outweighs the greater proportion of oil that he can get from bad copra. The reason why the amount of deterioration that occurs in copra is so great as compared with that in other comparable products, such, for instance, as palm oil, palm kernels, or cocoa, seems to lie in the system by which it is handled on the world's markets.

If one ships palm kernels, palm oil or cocoa from West Africa to Liverpool, New York, Hamburg or London, one sells on definite well-known clauses which specify the grades of quality with considerable accuracy and which are substantially the same in all these markets. In the case of the two former products, not only can one thus sell on a clause closely defining the quality of the produce, but the contract also provides for the payment of premia, or deductions of allowance, according to the variation of the parcel from the standard quality specified in the clause. In the case of cocoa, the system of futures, spot markets, and defined grades provides more elaborate machinery serving the same purpose of combining the advantages of forward sale or purchase with a final adjustment of price with very great exactitude according to the exact quality.

For copra we have simply the two grades of f.m.s. and fair merchantable, and the forward sale of these grades as such. Compared to the grade definitions in other products the meaning of these copra terms is extremely vague. They really amount to little more than "Fair Average Quality for the country concerned" and a quality distinctly lower than F.A.Q. but still recognisable as copra. This vagueness of definition of grades and the inability to buy or sell a standard grade forward with subsequent accurate adjustment of the spot price according to the quality delivered militate to discourage the buyer in the country of origin from paying more for superior quality. Until he does so, efforts to induce the producer to prepare a better quality naturally meet with little response.

This situation also renders almost impossible the introduction of any satisfactory system of official grading at source, such as has been introduced in recent years in respect of nearly every other important primary agricultural product that is marketed wholesale.

The special contracts made by some estates for regular sale of "estate quality copra" are not a contradiction of the statements made above; for though in such sales the buyer may get the exact quality he wants, and the seller get the extra price his quality deserves, both have to sacrifice the great advantage of trading in the open market. In any event this only affects estates, not the smallholders who produce a large proportion of the world's copra.

The considerations set out above are not theoretical ones. Let any one who is interested in the matter ask, for instance, Messrs. Cadburys or Messrs. Rowntrees if they would like to buy cocoa under the same conditions as copra is bought; and further ask them if they think that the quality of cocoa from West Africa would be what it is today if there were not accurate definitions in the standard clauses defining grades of cocoa.

Mr. Cooke discusses the range of quality of copra and the conditions under which it is marketed. He continues with a concise statement of the causes of deterioration and of the methods by which such deterioration may be obviated and concludes with a section on copra grading. The technique of preparation of copra must vary to suit local conditions, especially that of climate; but his recommendations are of a general character and simple to follow, so that there appears no good reason why the results of his investigations may not be translated into practice by producers at no great expense, and to the ultimate benefit of the industry.

* From a review by O. T. F. in the *Malayan Agricultural Journal*, XXV, No. 12, 1937, on *The Practical Aspects of Copra Deterioration*. By F. C. Cooke. Special Bulletin, General Series No. 28, Department of Agriculture, Straits Settlements and Federated Malay States. 1937. 49 pp. 3 plates. Price 50 cents (Straits currency) or 1*s*. 2*d*. post free.

REVIEWS.

SOIL SURVEY (RECONNAISSANCE) OF ANTIGUA AND BARBUDA, LEEWARD ISLANDS.

By Cecil F. Charter, *Crown Agents for the Colonies*, London, 1937, pp. 30, with two Soil Series maps and one plate, price 2*s*., obtainable from the Secretariat, Antigua, B.W.I.

This is the only satisfactory attempt that has so far been made in the British West Indies to prepare a detailed pedological map of a prescribed region, and to classify its soils by modern pedological methods. Previously, soil surveys in the British West Indies, performed by Officers of the Imperial College of Tropical Agriculture, were preliminary studies, undertaken solely with the objects of obtaining general information regarding the geological relationships of the main soil-types, the origin and development of soil profiles, and their agricultural potentialities. Such preliminary surveys necessitated the physical and chemical examination of very large numbers of profile soil samples by rapid quantitative methods, adopted for the purpose in the College chemical laboratories. They were intended to serve as a general guide and basis for further work (particularly in the field), with the ultimate aim of identifying, classifying and accurately mapping the whole range of the more important British West Indian soil-types, and eventually of relating them, not only with the well-known groups of soils recognised by American soil investigators in the Southern United States and the larger Antillean Islands, but also with World Groups. The limited time available for field work by Officers of the College has so far rendered progress very slow. It is fortunate that the author of the monograph under review (who occupied the post of Field Officer to a group of estates in Antigua) has been able to spend so much time in the field. He has thus been able to make a very thorough examination of his area, and his independent conclusions should go a long way to further our knowledge of the soils of Antigua. It should also form a model for similar detailed work in other British West Indian areas, especially those whose soils are derived mainly from sedimentary rocks in contrast to igneous.

Although Antigua is only just over 100 square miles in area, five suites of soils, representing 24 soil-series, have been differentiated by Mr. Charter. In Barbuda (which is an island 62 square miles in area, lying 25 miles north of Antigua), one soil-suite, comprising four soil-series, has been identified. Soils are grouped pedologically into *series* on the basis of the general features of their profiles, such as colour, content and distribution of lime, manganese peroxides and oxides of iron (which tend to form concretions at certain depths), soil structure, content and nature of soluble salts, position of the water-table and moisture relations generally, natural vegetation at the site, and nature of the parent rock material. The name given to a soil-series is usually that of the chief locality where the soils occur. Soil-series derived from the same, or lithologically similar, parent materials, are grouped into *suites*. The name given to a soil-suite is that of the chief soil-series in it. The suites recognised in Antigua are Montero Suite, (5 series) ; Otto Suite (9 series) ; Gunthorpe Suite (3 series) ; Fitches Suite (5 series) ; Elliot Suite (1 series) and Swamp Soils. The differences between the series within any one suite are due to differences in the parent materials, and to some extent, to variations in drainage and topography. The under-drainage is generally poor in the Antiguan soils, since the parent rocks are impervious clays or marls, and the topography is mostly low-lying. The clay content in each case is large (40 to 50 per cent. in the surface humic layer), and the clay material is a high-shrinking siliceous type.

Perhaps the most important fact established for the first time by Mr. Charter is the existence and significance in Antigua of wide-spread, though variable, superficial deposits of *lagoon clays*, laid down in Pleistocene to geologically recent times. These clays cover indiscriminately the various sorts of sedimentary tuffs, grits, gravels and limestones of Oligocene age, and many of the soil-series are derived from them rather than directly from the Oligocene sediments which they overlie.

Other important facts stressed by Mr. Charter are the occurrence, in the surface soils (0 to 1 ft.) and in the deep subsoils (4 to 4½ ft.) overlying non-calcareous materials, of black concretions and stains of manganese peroxide, and the presence of concretionary calcium carbonate at still lower depths (5½ to 6½ ft.). The occurrences of these accumulations in the soil profile are presumably due to downward leaching by rain and deposition by ground-water ; they are a distinctive feature of soils having impeded drainage (Vlei Soils), comprising a World Group often called Intrazonal. Similar soils occur in Texas and in China, and in many other parts of the world. The calcareous soils of the northern limestone district of Antigua (Fitches Suite) contain no such manganiferous accumulations ; their surface layers are grey to jet-black, and merge sharply into pale-coloured calcareous lagoon clays, deposited mainly over the eroded surfaces of hard limestone. The Fitches Suite belongs to the *Rendzina* (or humus-carbonate) group. No *Terra Rossa* soils (red soils derived from hard limestone) occur anywhere in Antigua, but one of the Barbuda soil-series is assigned by Mr. Charter to this group. Finally, the Shirley soil-series, belonging to the Otto Suite, is thought to approximate to the *Chestnut Earth*, first identified in S. E. Russia. It is a free-draining brown soil formed under low rainfall (35 ins.) and contains conspicuous accumulations of calcium carbonate at shallow depths.

The unravelling of the complicated relationships of the varied soils of Antigua is an achievement which reflects credit on the industry of the author of this monograph, and his exposition of many of the puzzling features of the Antiguan soils has explained many facts which so far had eluded previous investigators of this area. F. H.

* * *

THE COACHELLA VALLEY AND ITS DATE INDUSTRY.

By R. H. Postlethwaite, *V. V. Green*, Coachella, Calif., 1938, pp. 47, price $0.25.

This excellent brochure gives the first published survey of the Californian date industry as a whole, including marketing conditions and the reasons why "during the last six or seven years the Coachella Valley date industry has been in a deplorable condition." The author is a grower of twenty-three years standing, an engineer of date machinery and packing plants, and a public-spirited worker for the good of the industry and of the valley. He considers the requirements for a return to prosperity to be co-operation between growers, the production of high grade, long-keeping dates, the cessation of competitive reduction in prices and the establishment of a fair selling price, the removal of low-grade dates from the market and their employment in by-products, and the establishment of a proper sales organization. The climate of the valley he finds suitable for date culture and gives the water requirements of dates as 6.5 acre-feet per year. Planting with Daolat an-Nur, Khadrawi and Zahdi dates is advocated, in order that the planter should not have all his eggs in one basket, and that the picking season be lengthened with a consequent smoothing out of the labour peak.

Mr. Postlethwaite estimates that $2.70 per year would be spent on every full-grown palm for manures, without counting cover crops. This expenditure would provide 6¾ lb. nitrogen, 6½ lb. phosphoric acid and 8 lb. potash. The yield of a palm is expected to be not less than 200 lb. It must be remembered that dates in California are picked when they contain twice as much water as those which are picked in the Iraq. An analysis of the import of dates into America in 1936 is given. The total import was 23,794 tons, of a value just under two million dollars, before payment of duty the average duty levied amounting to 40 per cent. of the *c.i.f.* value.

A brief review of the diseases and pests of date palms in California is given. It is noted that there are those who do not agree with Dr. Bliss in attributing "decline disease" to a fungous origin, and who maintain that it is a deficiency disease. An outline of processing treatments for different qualities of dates is given, together with evidence of their success in preventing sowing and in maintaining them in good condition. Cold storage is not recommended. Brief notes are also given in packing-house layout and on costs of construction and on the machinery required. V. H. W. D.

AGRICULTURAL ANALYSIS.

A Handbook of Methods, excluding those for Soils, by C. Harold Wright, *Thomas Murby & Co.*, London, 1938, pp.343, price 16s.

This book describes in detail methods of analysis for fertilizers (including lime and limestone), feeding stuffs, milk and milk-products, and insecticides and fungicides. In the introduction, the author lists, with a short review of each, nine publications to which the analyst may have recourse for the interpretation of his results. Following this, there is a short chapter devoted to the all-important part of every analysis, namely, preparation of the sample, with some consideration of the correction for adhering soil in plant material. In the following 72 pages, methods applicable to the various classes of fertilizers are dealt with at length. Feeding-stuffs occupy the next 96 pages; milk and milk-products 78, and insecticides and fungicides 40 pages. The concluding section describes the preparation of indicators and standard volumetric solutions, and in the appendices, factors for calculation of results are given.

Throughout the book, due attention is paid to official methods, both those of the A.O.A.C., as well as the British equivalent. In addition, many alternative methods are included in the text which the general, or even the research worker, will find of great value as a saving in time when searching through literature which very often may not be easily accessible. A notable feature of the book is the general introductory remarks to each section, in which the author draws attention to the various points of interest in the methods described in the pages following. Thus, to take an example at random, nine pages are devoted to a general discussion on the precipitation of phosphate before details of the various methods are given. This enhances the value of the book considerably, especially to the student with limited experience.

The general lay-out of the book is on the same style as the author's previous publication—Soil Analysis—to which it makes a most suitable companion and which the Agricultural Chemist will find invaluable in the laboratory.

G. R.

* * *

FOURTH INTERNATIONAL GRASSLAND CONGRESS, ABERYSTWYTH, 1937, pp. 486

The full report of the Fourth International Grassland Conference to which reference was made in our leader of December last is now to hand. It is in English and German and every paper is printed in full in one of these languages with an abstract in the other.

The Conference was organised in six sections and studied the grasslands of the word from every point of view and this volume of nearly 500 pages forms a valuable record of the papers that were read and the discussions to which they gave rise.

R. C. W.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Absorption of Mineral Nutrients by Sugar-Cane at Successive Stages of Growth.—*A. Ayres.*

Abnormal or subnormal growth of sugar-cane may be due to pathological conditions, or to unbalanced nutrition; as regards the latter condition, information is sometimes sought by analyzing the cane to ascertain the relative proportions and amounts of the different nutrients. Such analyses, however, have little significance unless compared with analyses of cane grown under conditions where the nutrients in the soil are known to be in balance, or, if this cannot be or is not ascertained, the reference cane should be grown in a soil which is thought to be normal. The author therefore selected a field of H. 109 first ratoons, which was supplied with nutrients in amounts generally considered adequate for a satisfactory crop. Representative stalks were analyzed at monthly intervals for 14 months.

It was found (in agreement with many prior researches) that the percentage compositions of the leaves and stalks of the sugar-cane are markedly influenced by the age of the plant, particularly during the early months of growth. Hence, analytical data may be of little significance for comparative purposes, unless the age of the cane is taken into consideration. It was further found (also in agreement with previous knowledge) that the principal nutrients are taken up in widely different amounts; potassium and silicon were taken up to a greater extent than nitrogen and phosphorus, and calcium and magnesium in the least amounts. In all cases (except that of silicon), maximum rates of absorption were attained at the age of three months, although some nutrients, as nitrogen, were absorbed at seemingly faster rate than others. After the maximum rate was passed, the rates of absorption of all nutrients decreased. All this goes to show that absorption of nutrients by sugar-cane is not primarily a function of the rate of growth, but of the age or state of development of the cane.—(*Facts About Sugar*, Vol. 33, No. 5, pp. 38-39, 1938.)

* * *

A Promising New Cane Variety in Barbados.—*S. J. Saint.*

Among the more promising new varieties, B. 3013 is singled out for special discussion. As plant-cane, this variety outyielded the standards in three out of four years, and markedly so in the years 1936 and 1937. The 1936 crop enjoyed a higher than average rainfall, while the rainfall for the 1935 crop was below average. The conclusion is that B. 3013 will yield slightly less than the standards in years of low rainfall, but will give higher yields in years of average or above average rainfall. The most marked superiority of B. 3013, however, is as a ratooner, even in low rainfall years. Besides giving higher ratoon yields, it appears probable that it will ratoon profitably for a longer number of seasons. It retains its fresh appearance throughout the crop, and sprouts readily and strongly after being cut. In its content of sucrose, B. 3013 is close to B. 726 and superior to B.H. 10 (12). Maturity experiments have shown that it ripens soon after B. 726. It is an unusually sound seedling, showing little cane-rot, and is comparatively little attacked by rats. (*Facts About Sugar*, Vol. 33, No. 6, p. 38, 1938.)

* * *

Dryage Effect on Sugar-Cane.—*R. P. Sanghi, N. C. Dutta and Gyan Chandria.*

Since Indian cultivators generally refuse to deliver cane at night or in bad weather, it is necessary for the factories in the North-western districts to accumulate a supply for continuous operation. In view of this condition, the authors made yard storage experiments in which piles of cane were sprinkled heavily, lightly, or not at all with water. The variety used was Co. 312. Without any sprinkling, the dryage percentage rose to 5.92 within four days. Primary juice purity fell from 82.28 to 76.60, and invert sugar rose from 0.82 to 2.28. In other lots of cane, sprinkled once a day at 8 a.m., the dryage percentage in four days was 3.16; primary juice purity fell from 83.29 to 81.95; invert sugar rose from 0.78 to 1.39 per cent.

Another lot was sprinkled three times a day, morning, noon and afternoon. Dryage in four days was 4.02 per cent. purity fell from 81.77 to 76.68, and invert sugar rose from 0.83 to 1.82 per cent. In all cases, the rate of deterioration increased from the fifth day on, but the increase in invert sugar and loss of purity were less pronounced in the lot that was sprinkled once a day than in either the unsprinkled or the excessively-sprinkled lots.—(*Facts About Sugar*, Vol. 33, No. 5, p. 34, 1938.)

* * *

White Sugar and Molassine Gul Manufacture by the Open Pan Process. *By V. V. Gadgil.*

In the Bombay Deccan, there is much cane grown that cannot be supplied to a regular sugar factory, and low prices for the locally produced molasses sugar, *gur* or *gul*, have been disastrous to the small cultivators. To improve their situation by enabling them to prepare a better product that could be sold at a higher price, the Bombay Department of Agriculture has devised a simple process involving the use of an active carbon locally made from rice hulls. The outfit consists of a hopper having a screen, at the bottom of which is placed a layer of sand, a 4-inch layer of carbon, and a filter cloth; the raw juice, after boiling 10 minutes with 2 per cent. of carbon and filtering through this system, has a clarity equal to that of limed juice and a high quality "rab" can be prepared from it. The costs are moderate. (*Facts About Sugar*, Vol. 33, No. 6, p. 35, 1938.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

New Synthetic Flyspray Base to Replace Pyrethrins in Substantial Proportion for use in Insecticides.

A new synthetic flyspray base, capable of replacing a substantial proportion of the pyrethrins now used in household insecticides, has been announced by E. I. du Pont de Nemours & Co. This compound, known as isobutyl undecylenamide (an alcohol derivative combined with a vegetable oil derivative) was developed in the du Pont laboratories from research undertaken at the request of the insecticide trade, because of the increasing difficulty of getting a uniform and reliable source of pyrethrum for the ever-growing flyspray market. Attempts to cultivate pyrethrum in the United States have been unsuccessful because this country cannot compete with cheap foreign labour in harvesting the flower-heads. Accordingly, the pyrethrum used in the U. S. A. is imported, largely from the Far East, Africa and Central Europe. The crop varies widely from year to year in both quality and quantity. The facts that there is little authentic information available on the crop until after the harvest, and that American importers must buy it sight unseen, have given rise to an uncertain market and a great deal of speculation. The present Sino-Japanese conflict has caused even more uncertainty. This situation prompted the research by which isobutyl undecylenamide was developed.

The introduction of isobutyl undecylenamide as an improved ingredient for flyspray is significant in that, not only has it been tested and proved as a compound extremely efficacious in the field for which it is intended, but it has also been carefully investigated for its possible poisonous effects upon those who may use it. The results of this toxicological investigation have shown that the compound is safe for use as a flyspray without fear of injurious effects to persons or household pets. The experimental work on the possible physiological effects of this new compound on animal life was conducted at the Haskell Laboratory of Industrial Toxicology of the du Pont Company, and the modes of administration were by mouth, subcutaneous injection, inhalation of mist and application to the skin. Administration-by-mouth experiments were done on rats, the animals being fed various sized doses from 0.5 to 10 cc. per kilogram body weight. The minimal fatal dose killing 70 per cent. of the animals in 20 to 90 minutes was 4 cc. per kilogram body weight, indicating a relatively low toxicity. A second group of rats were fed 2 cc. of isobutyl undecylenamide every second day for a period of six weeks. None of these animals showed toxic symptoms, and all gained weight during the experiment. Subcutaneous injections of 1.15 to 7.27 cc. per kilogram body weight, using rats and mice, gave no evidence of toxic action.

In order to determine whether or not isobutyl undecylenamide is liable to produce irritation to the skin, 1 cc. was applied daily to the shaven backs of white rats five times a week for seven weeks. None of these animals showed any skin irritation and the hair continued to grow at the site of application. The inhalation experiments were performed to determine whether isobutyl undecylenamide would produce lung irritation or any remote effects as the results of absorption through the respiratory tract. Rabbits were subjected to the mist of isobutyl undecylenamide for one and one-half hours a day up to 15 days. This mode of administration did not result in lung irritation or any other toxic effects. All experimental animals were subjected to gross and microscopic pathological examinations. The inhalation and skin application experiments represent the conditions under which the user will be subjected to the normal exposures to isobutyl undecylenamide. Inasmuch as the compound shows no toxic effects upon animals under conditions which are extreme, it is safe to assume that, under normal conditions, the human will not be affected by any untoward symptoms either from skin irritation, nasal or lung irritation or toxic effects as the result of absorption.

The above data indicate that isobutyl undecylenamide meets one of the foremost requirements of a flyspray ingredient : namely, that it can be placed in the hands of the public with assurance that it may be used for the purpose for which it is recommended with safety and no untoward effects upon body health. Other less vital but important characteristics of a flyspray base, such as lack of objectionable odour and of staining fabrics and wallpaper, have been tested in the du Pont and outside laboratories and found satisfactory in the case of isobutyl undecylenamide. Until now no substance had been found which is as satisfactory as pyrethrum from the viewpoints of efficiency, safety to humans, and the other requirements of a flyspray ingredient. Isobutyl undecylenamide provides a domestic source for a potential substitute.—(*Agricultural News Letter* (*Du Pont*), Vol. 6, Nos. 6 and 7, pp. 99-100, 1938.)

* * *

Tobacco Frenching and Thallium.

Frenching, a disease of tobacco and other plants, is believed by Dr. Spencer (Rockefeller Institute for Medical Research, Princeton, N. J.) to be due to thallium poisoning. Thus, 0.067 p.p.m. of thallium in a culture solution will produce the frenching symptoms ; species susceptible to frenching are also sensitive to thallium, and both conditions are overcome by nitrogen fertilisers, by aluminium sulphate, and by potassium iodide. Whether frenching soils contain the required amount of thallium could not be determined, since present chemical methods are not sufficiently sensitive to detect in the soil such traces of thallium as are needed to produce the symptoms.—(*Ind. Eng. Chem., News Edit.*, Vol. 16, No. 1, 1938, p. 3.)

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.).

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
30th June	5	0	8	9
7th July	5	0	8	9¾
14th July	5	5¼	9	3
21st July	5	5¼	9	2½
28th July	5	5¼	9	1½
4th August	5	5¼	9	1½
11th August	5	5¼	9	0¾
(*12th August*, 1937) ...	6	8¼	10	5¼

The International Sugar Council has now published the results of the recent Conference in London, events having taken a somewhat unexpectedly favourable turn. Considering the statistical position in regard to the first quota year ending 31st August, 1938, the Council estimated the free market requirements at 3,038,000 tons, and decided that 100,000 tons should be taken into account as an estimate of reserve stock purchased by the British Government. It was decided that 47,000 tons of this additional amount should be supplied by the British Colonies and the remaining 53,000 tons met by exporting countries outside the British Empire.

* * *

Rubber.—Quotations for Plantation Sheet have ranged as follows:—

	Pence per lb.
29th June	6 7-8
6th July	7 1-4
13th July	7 3-8
20th July	7 1-2
27th July	7 13-16
3rd August	7 11-16
10th August	7 3-16
(*11th August*, 1937)	8 13-16

Consumption in the U.S.A. showed an increase in June of 1,682 tons to 30,629 tons, the highest monthly total for six months. Following on the decisions of the International Rubber Regulation Committee there was some selling which was easily absorbed. With the decline of world stocks prices have advanced further and a definitely firm tone has continued to develop.

* * *

BANANAS.—Prices have continued unaltered £19 15*s.* per ton delivered London and £19 10*s.* nearest station Provinces for Jamaicas and £16 London and £17 Provinces for Brazilians. Demand is showing signs of falling off and business has not been so active.

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian Giza 7.*	*F.G.F. Sakel.*
24th June ...	4.83	7.15	7.75
1st July ...	4.96	7.10	7.55
8th July ...	5.16	7.53	7.98
15th July ...	4.88	7.30	7.75
22nd July ...	5.06	7.50	7.95
29th July	4.99	—	—
5th August	4.89	—	—
12th August ...	4.78	—	—
(*13th August*, 1937)	5.93	—	9.28

There are no indications of better conditions in Lancashire, a limited enquiry being reported both for export and home trade. Owing to uneasiness about the international political situation, buyers have not had sufficient confidence to place large orders. The Sea Island market remains neglected, sales being confined to 250 bales Antigua at 1*s.* 3*d.* to 1*s.* 6*d.* per lb. and one small lot St. Lucia at 1*s.* 5*d.*

* * *

COCOA.—The cocoa market during the past month has been very quiet, buying interest on the part of manufacturers being conspicuous by its absence, and what little business was done seemed to be confined entirely to speculators and dealers. At present the market is controlled by outside interests and outside conditions, but as general conditions seem to be on the up trend, higher prices appear likely. Accra is quoted at 21*s.* 6*d.* and locally $5.70 per fanega is paid for Plantation Cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

GRAPEFRUIT.—Jamaican seeded fruit did not meet a very keen demand and was selling at from 8*s.* to 11*s.* per case. Trinidad seedless fruit was reported to be of good quality and was in steady demand at 12*s.* to 18*s.* per case. A small quantity Southern Rhodesia seedless fruit arrived in good condition, but only realised from 9*s.* to 12*s.* per case.

* * *

LIME PRODUCTS. *Lime Oil.*—The nominal value of Handpressed remains unchanged at 32*s.* 5*d.* per lb. There is no change in Distilled. *Lime Juice.*—There is still no demand for Concentrated, but Raw is quietly steady and has been fetching 1*s.* 9*d.* to 2*s.* 3*d.* according to quality. —(*West India Committee Circular*, 28th July.)

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